Greywater treatment in sustainable sanitation

Univ. Prof. Dr.-Ing. Ralf Otterpohl
Director
Institute of Wastewater Management
and Water Protection

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Hamburg University of Technology

aww
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Bubble Rain: full pleasant shower at 6 l/min

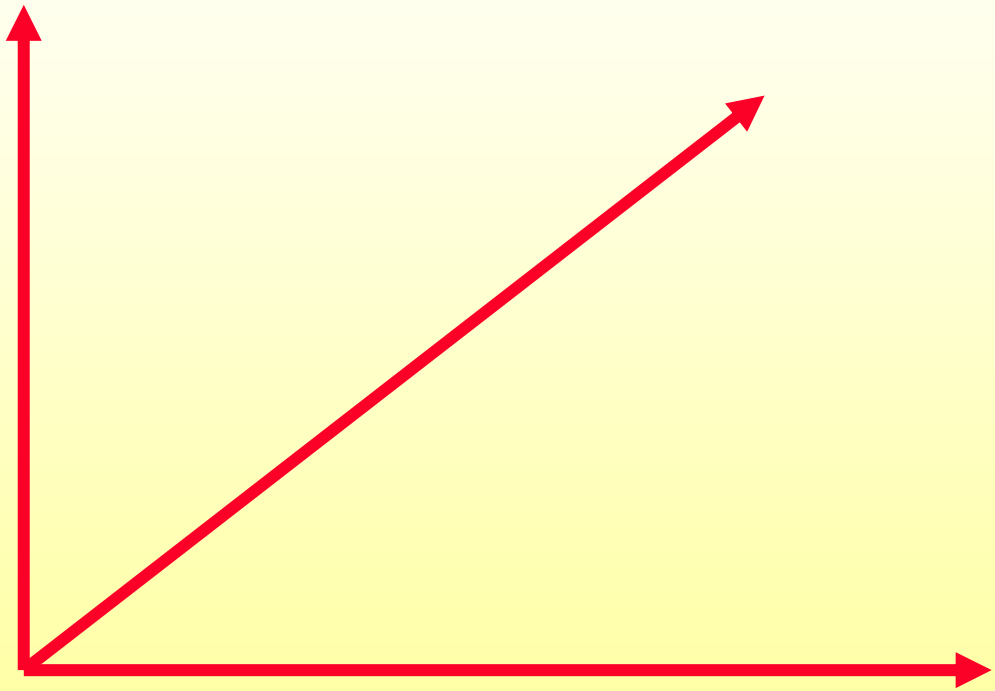
Shower gel into water

When is there greywater?

The 3 dimensions of Innovation

Concept Innovation

Formal Innovation



Technical Innovation

Source: Prof. G. Teodorescu, Stuttgart

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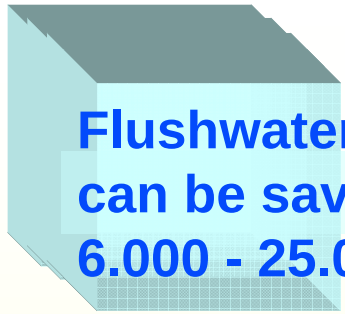
Volume l/(P*year)

Yearly Loads
kg/(P*year)



Urine
~ 500

Feaces
~ 50
(option: add biowaste)

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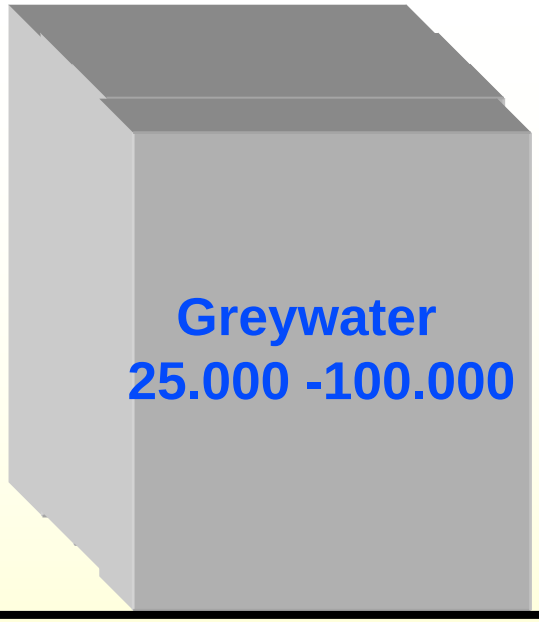
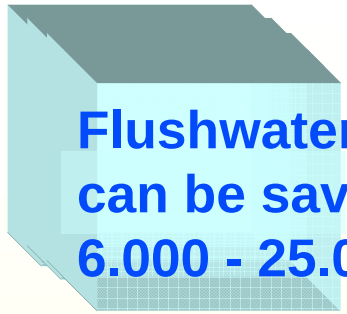


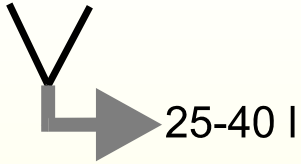
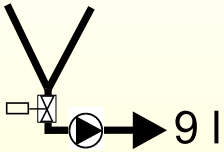
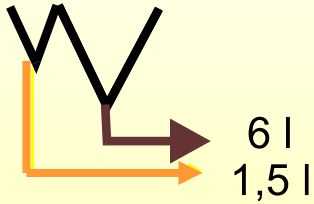
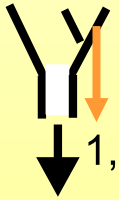


Yearly Loads
kg/(P*year)

		Greywater	Urine ~ 500	Feaces ~ 50 (option: add biowaste)
N	**~ 4-5**	~ 3 %	~ 87 %	~ 10 %
P	**~ 0,75**	~ 10 %	~50 %	~ 40 %
K	**~ 1,8**	~ 34 %	~ 54 %	~ 12 %
COD	**~ 30**	~ 41 %	~ 12 %	~ 47 %
S, Ca, Mg and trace elements		Treatment → Reuse / Water Cycle	Treatment → Fertiliser	Biogas-Plant Composting → Soil-Conditioner

Geigy, Wiss. Tabellen, Basel 1981, Vol. 1, LARSEN and GUJER 1996, FITSCHEN and HAHN 1998

Toilets and resulting Dilution

Type of Toilet	Daily Flow per P.	Pro and Con's
Flushing toilet		+ widely accepted - waste of water - high dilution
Vacuum-toilet		+ low water demand + well developed (ships) - high-tec / expensive
Separating toilet		+ little water / little dilution + simple fertiliser reuse - little experience
Waterless Urinal		+ no water / no dilution - maintenance required
Composting-toilet Desiccation toilet	 	+ no water needed - high space demand - maintenance needed ++ Desiccation for hot climates

Sustainable Sanitation has 3 main Development lines

1. **Dry sanitation / Low Cost solutions**
2. **Urine-Diversion with flush sanitation**
3. **Blackwater and integrated systems design**

Sustainable Sanitation has 3 main Development lines

… there is greywater left in all of them

and for more urban areas the rainwater runoff – modern way is infiltration and reuse where possible: Rainwater Harvesting

10 5 2005

How to treat greywater?

what reuse is feasible?

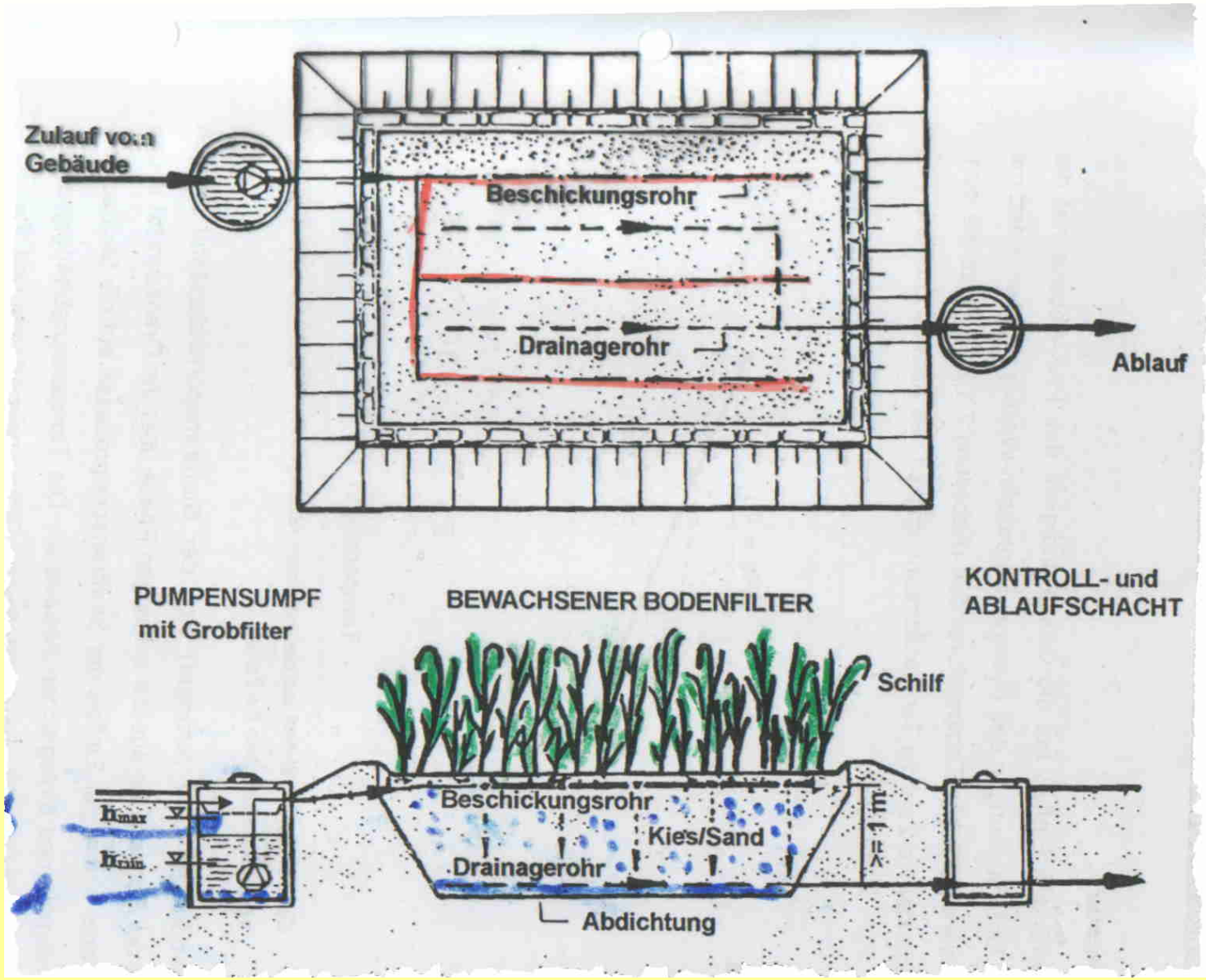
How to treat greywater?

what reuse is feasible?

Constructed Wetlands, Yes, BUT…

Constructed Wetland / Bio-Sandfilter:

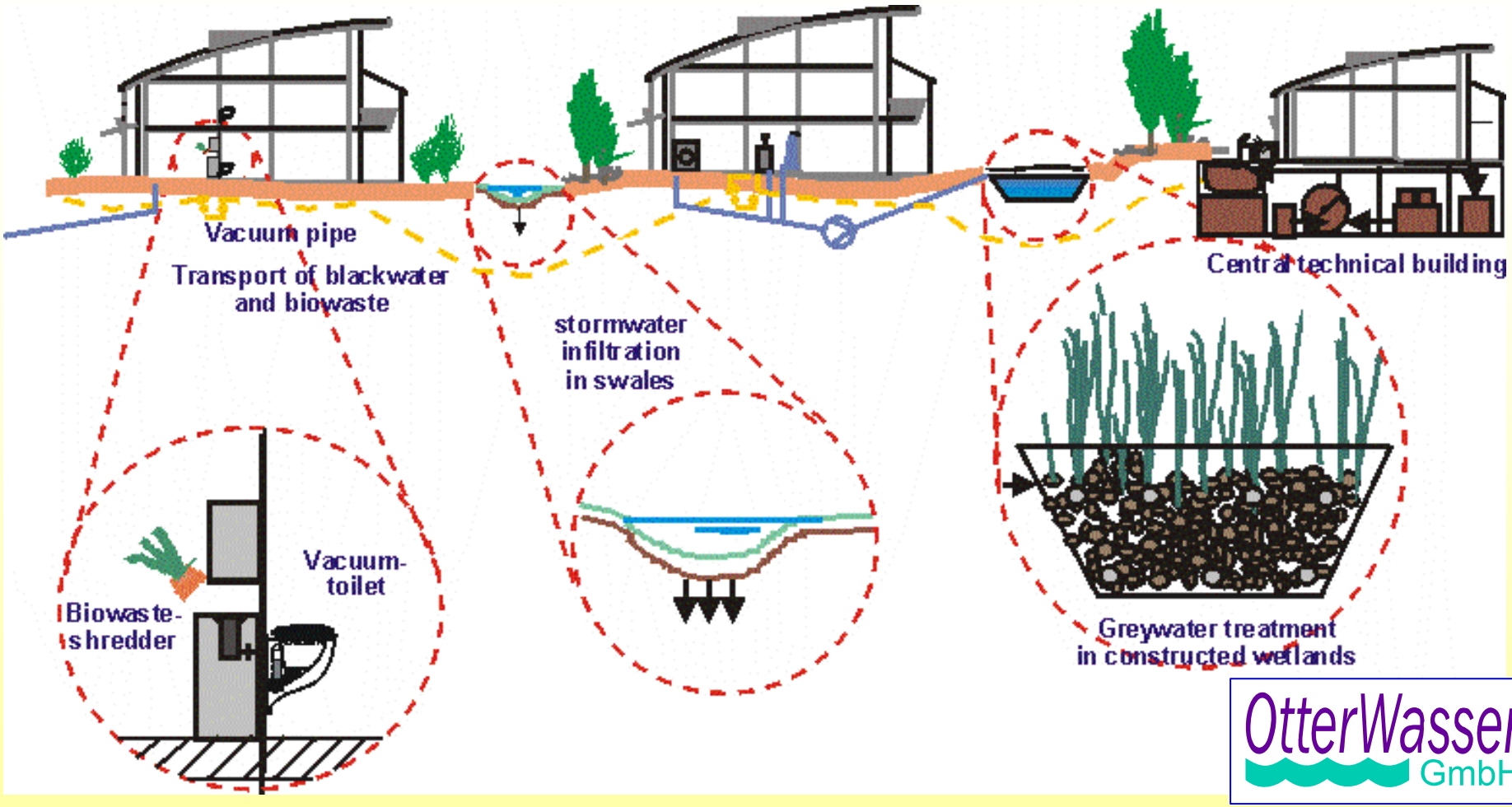
1. vertical flow 2. water level at bottom 3. intermittant feeding



Ecological Settlement Lübeck-Flintenbreite

Double-Houses

Terraced Houses



OtterWasser GmbH

Peri-Urban Settlement Lübeck-Flintenbreite (design 250 inhabitants)

Vacuum-Biogas-System for Blackwater plus Biowaste

Otterwasser GmbH, Lübeck www.otterwasser.de

Greywater treatment:
Constructed wetland / Bio-sandfilter
vertical flow, subsurface, sand 0-4mm
2m² per capita (cold climate, else less)
Lübeck-Flintenbreite, Germany

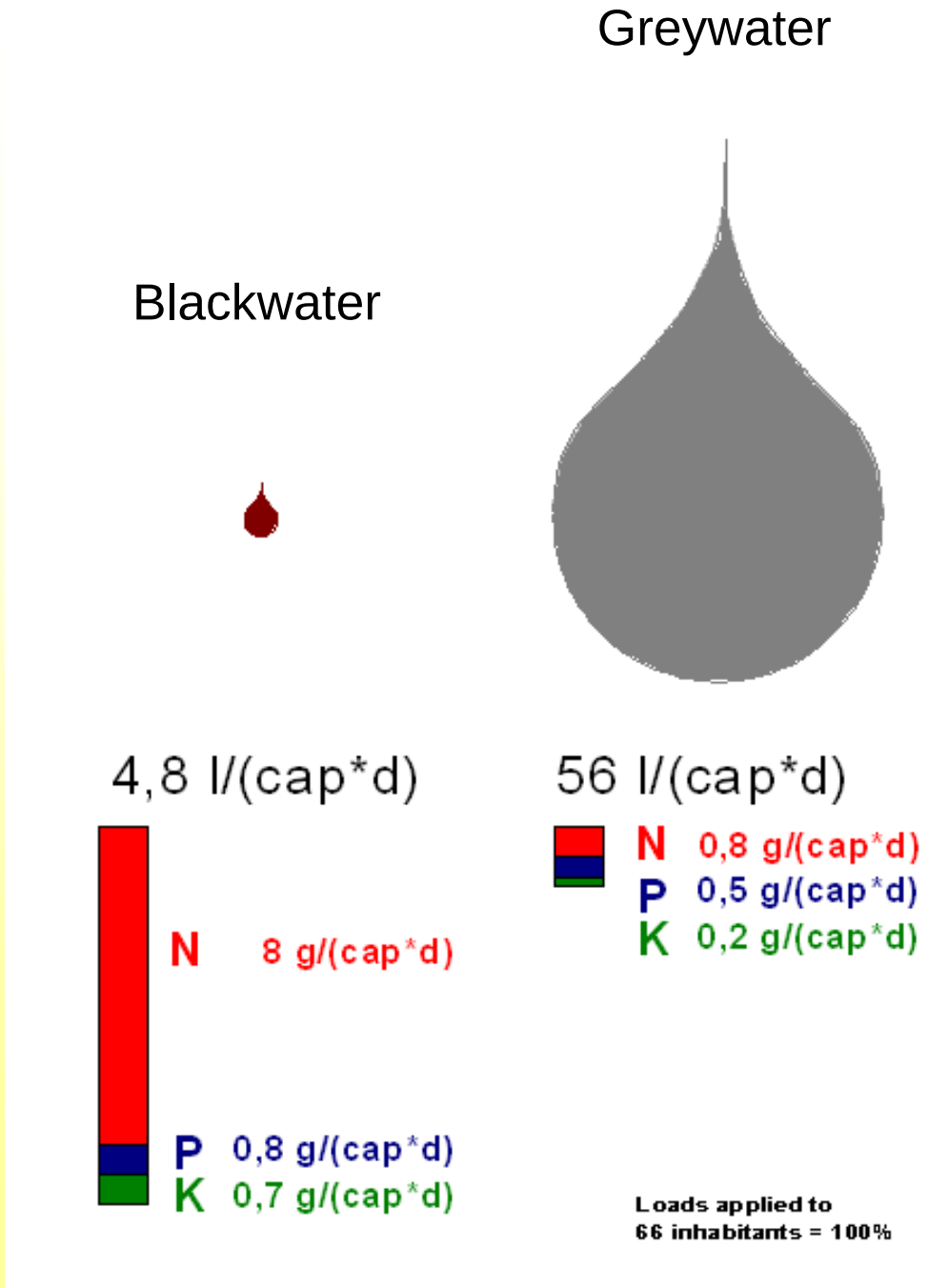
OtterWasser GmbH

OtterWasser GmbH

Clean effluent,low in nutrients

Nutrient loads in blackwater and greywater: measured values

more phosphate than expected, from dishwasher tablets



OtterWasser GmbH

Eco-Settlement ‚Braamwisch', Hamburg, Germany

- **Blackwater separate, treatment in composter**
- **Greywater in constructed wetlands**
- **Solar energy usage**

EVA Lanxmeer, Culemborg / Utrecht, The Netherlands

Initiative by Marleen Kaptein and and the city council ofCulemborg

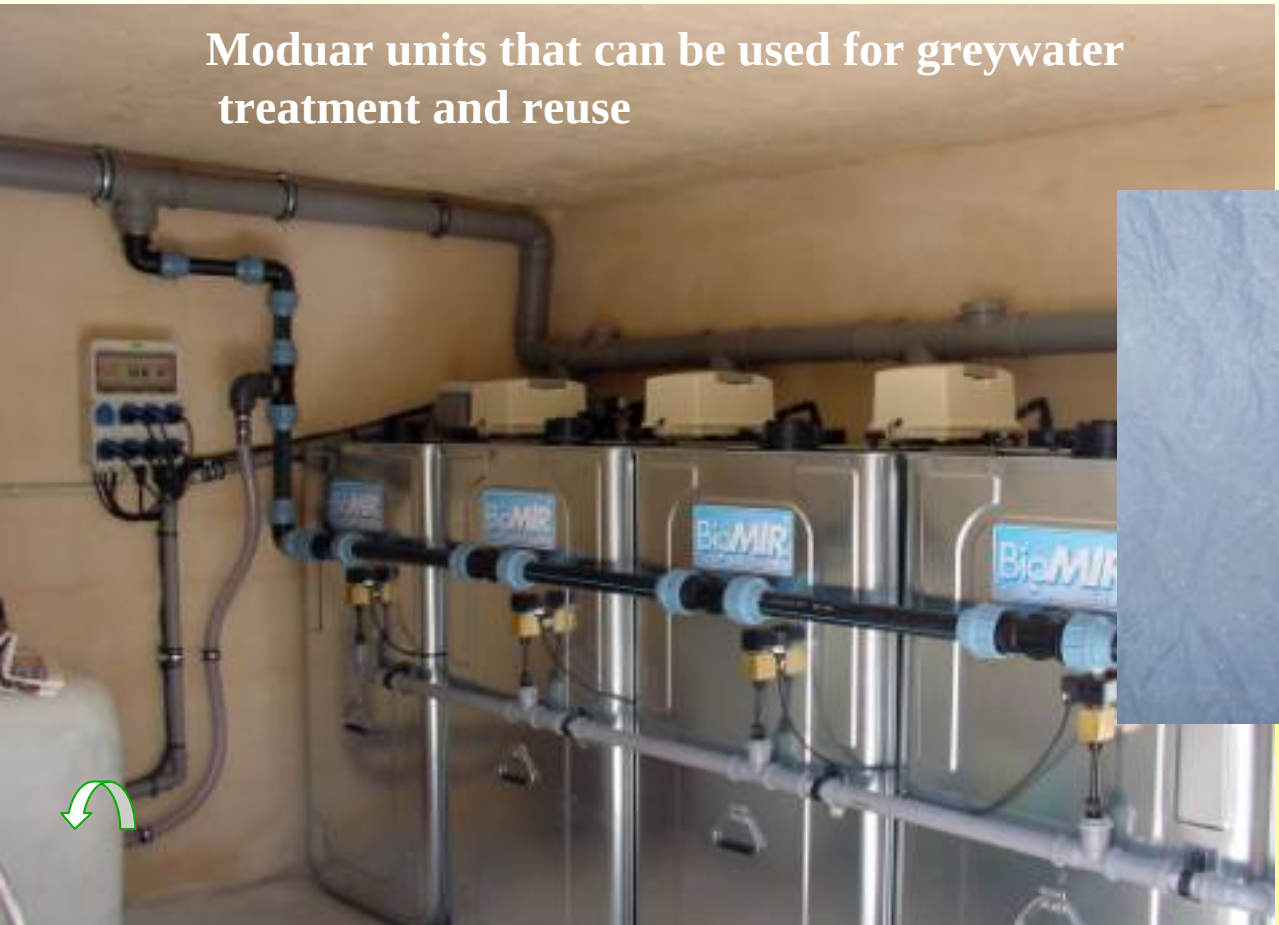
- **Planned for 1.000 inhabitants, small industry and conference centre**
- **Blackwater separate, treatment in biogas plant**
- **Greywater in constructed wetlands plus aquaculture**
- **Solar energy usage and semicentral heat supply from earth-water heat pump**

MBR is an excellent option for water reuse, sanitisation is includes as bacteria do not pass the membrane

Cost efficiency is better in case of reuse as there is a direct revenue

Make sure that maintenance is assured

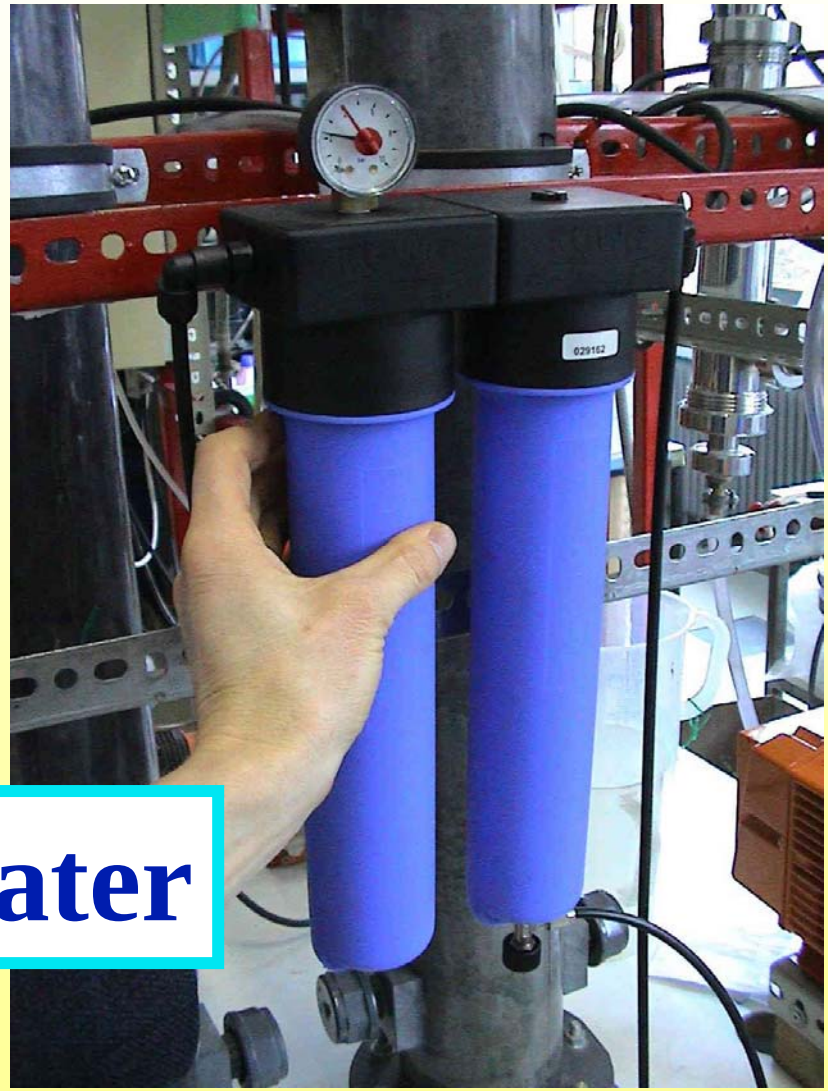
Moduar units that can be used for greywater treatment and reuse



Busse, Germany

Membrane module

Biological Treatment Microfiltration, Reverse Osmosis



Greywater to Tapwater

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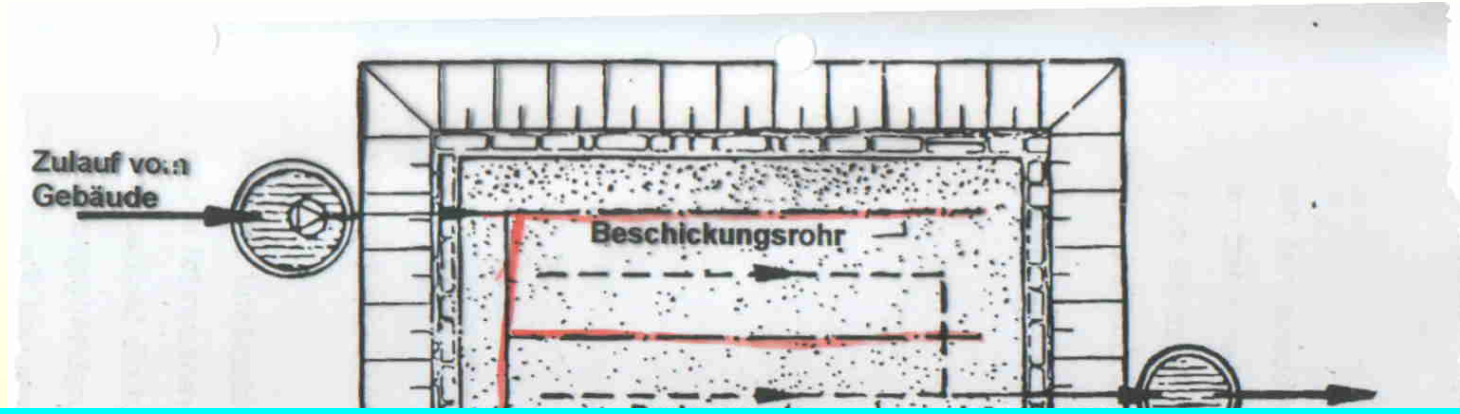
De-siccation Toilet
with solar heating of the 2 chambers
Mali, West Africa
GTZ / Otterwasser GmbH

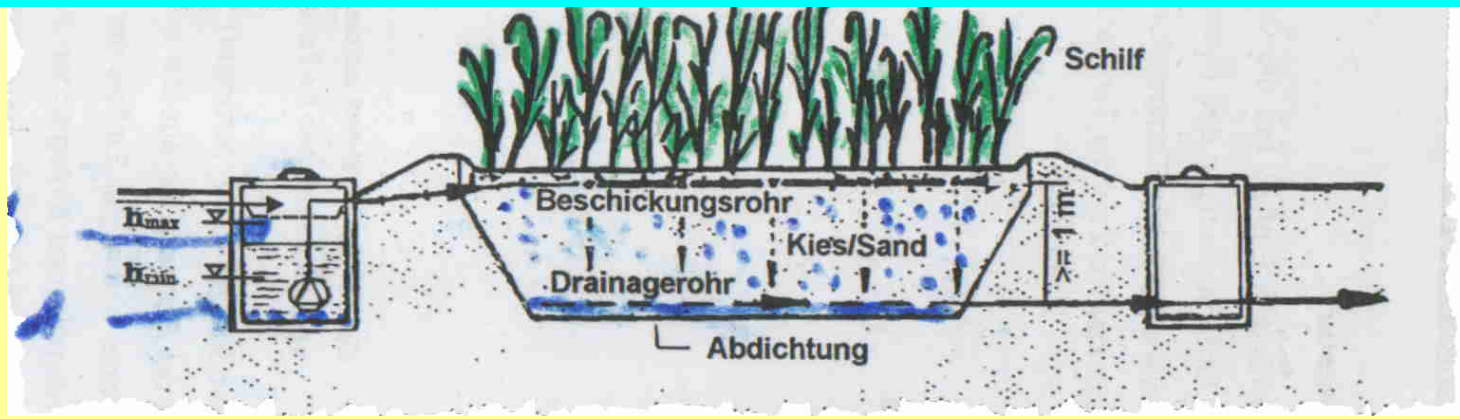
OtterWasser GmbH

Constructed Wetland / Bio-Sandfilter:

1. vertical flow 2. water level at bottom 3. intermittant feeding



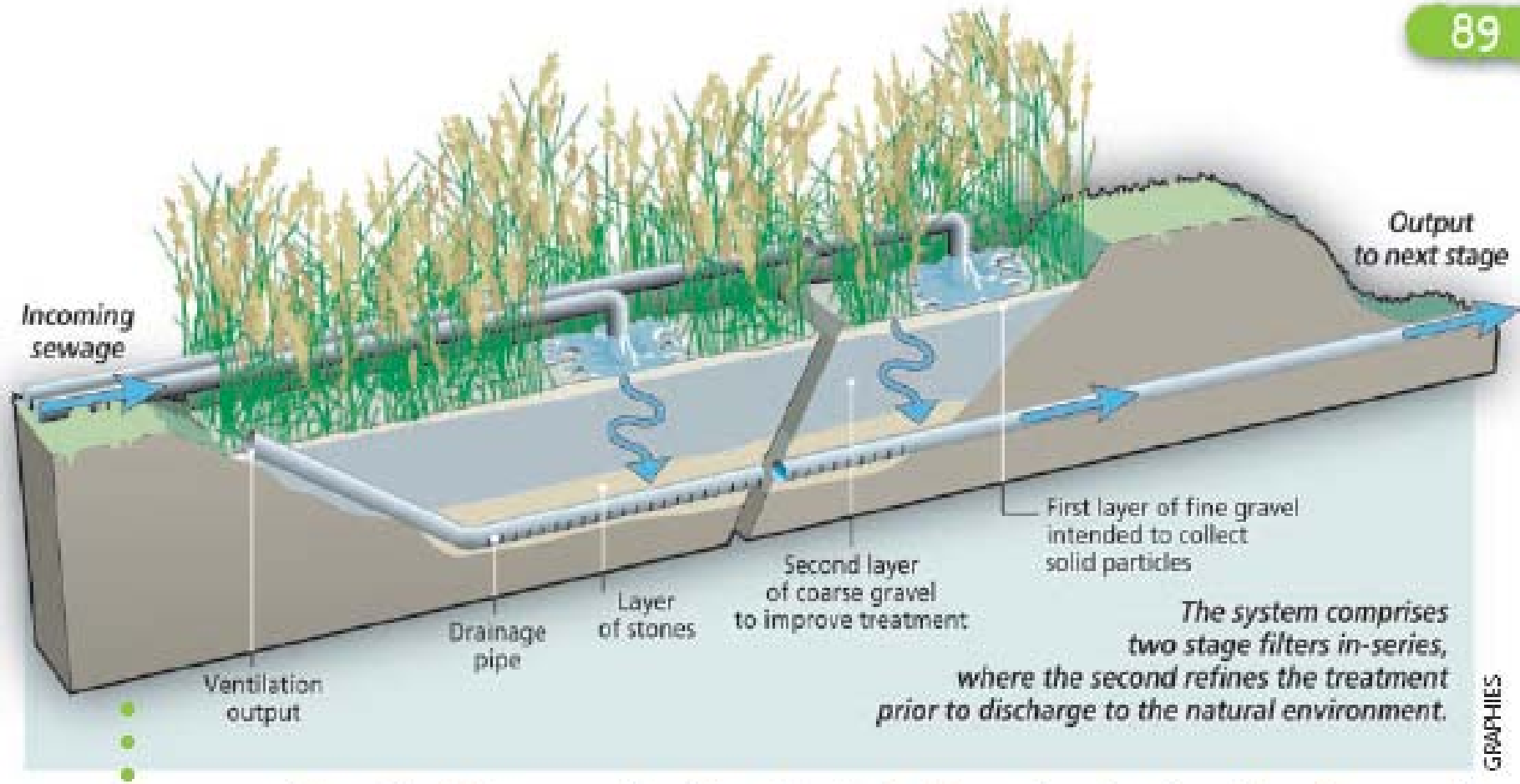
Traditional CW design everywhere?



Solar desiccation of feaces, Mali, West Africa (GTZ / Otterwasser)

Greywater biofilter in Mali, West Africa

Boata



Simplified diagram of a filter planted with reeds, developed by Cemagref.

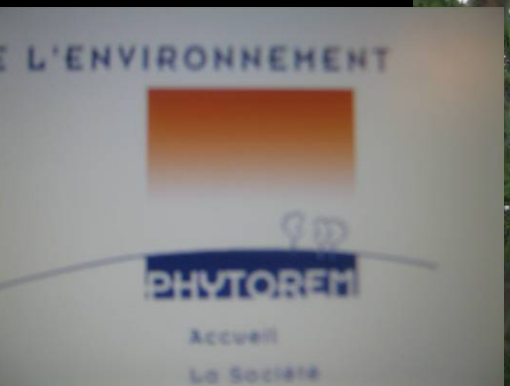
SINT
Société d'Ingénierie
NATURE & TECHNIQUE

CEMAGREF, France

Queige (73) – 500 p.e. – Phragmifilter® wastewater treatment plant

CEMAGREF, France

Bamboo for Wastewater Treatment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A vision…

of a beautiful city

where mass flows finally work out

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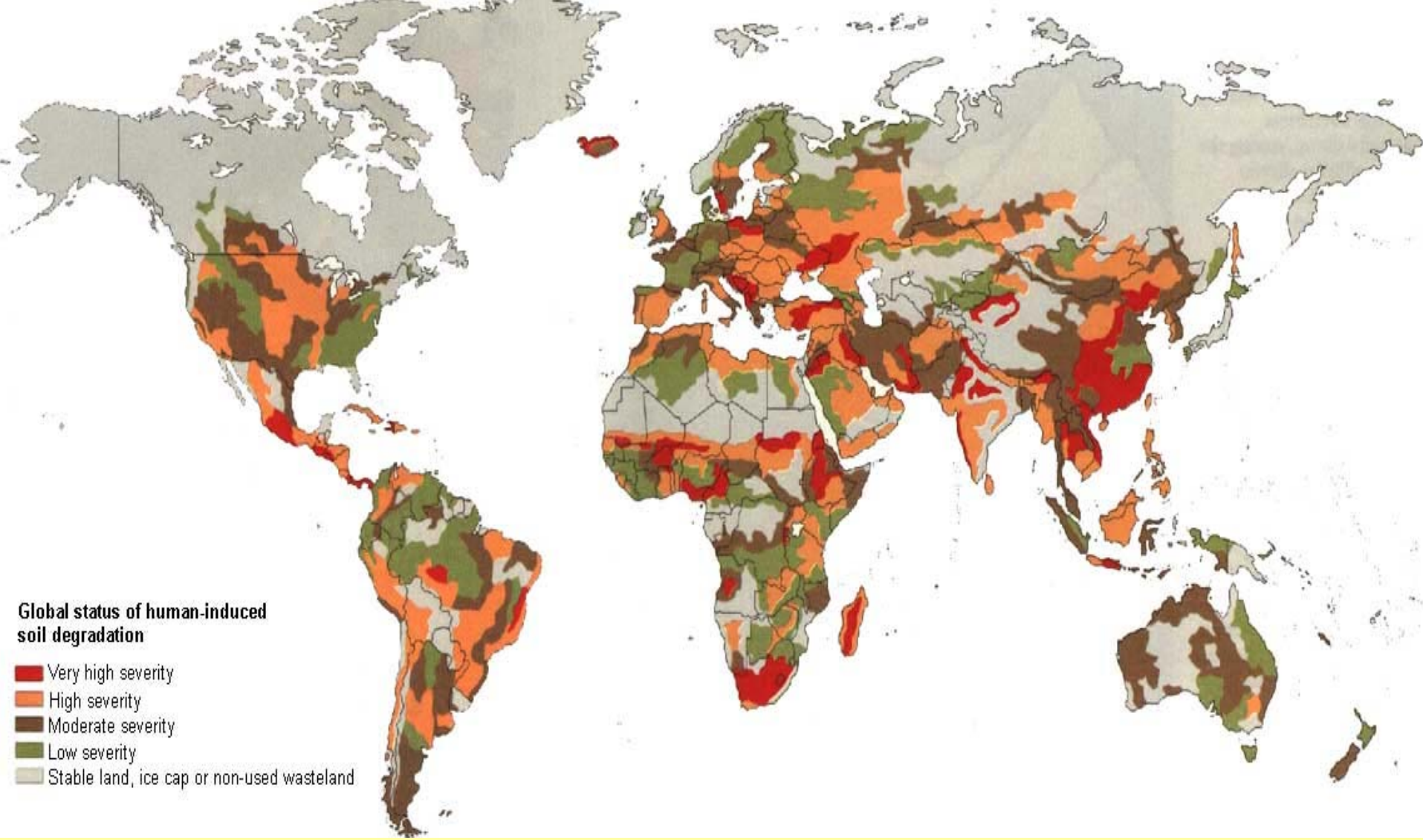
Breakthrough in faecal matter treatment trough vermicomposting at TUHH (BMBF / IPSWaT)



Loss of Soil Fertility (slow but dramatic, global scale)
counteraction by returning treated biowaste and faecals

(Map from WWW.FAO.ORG)

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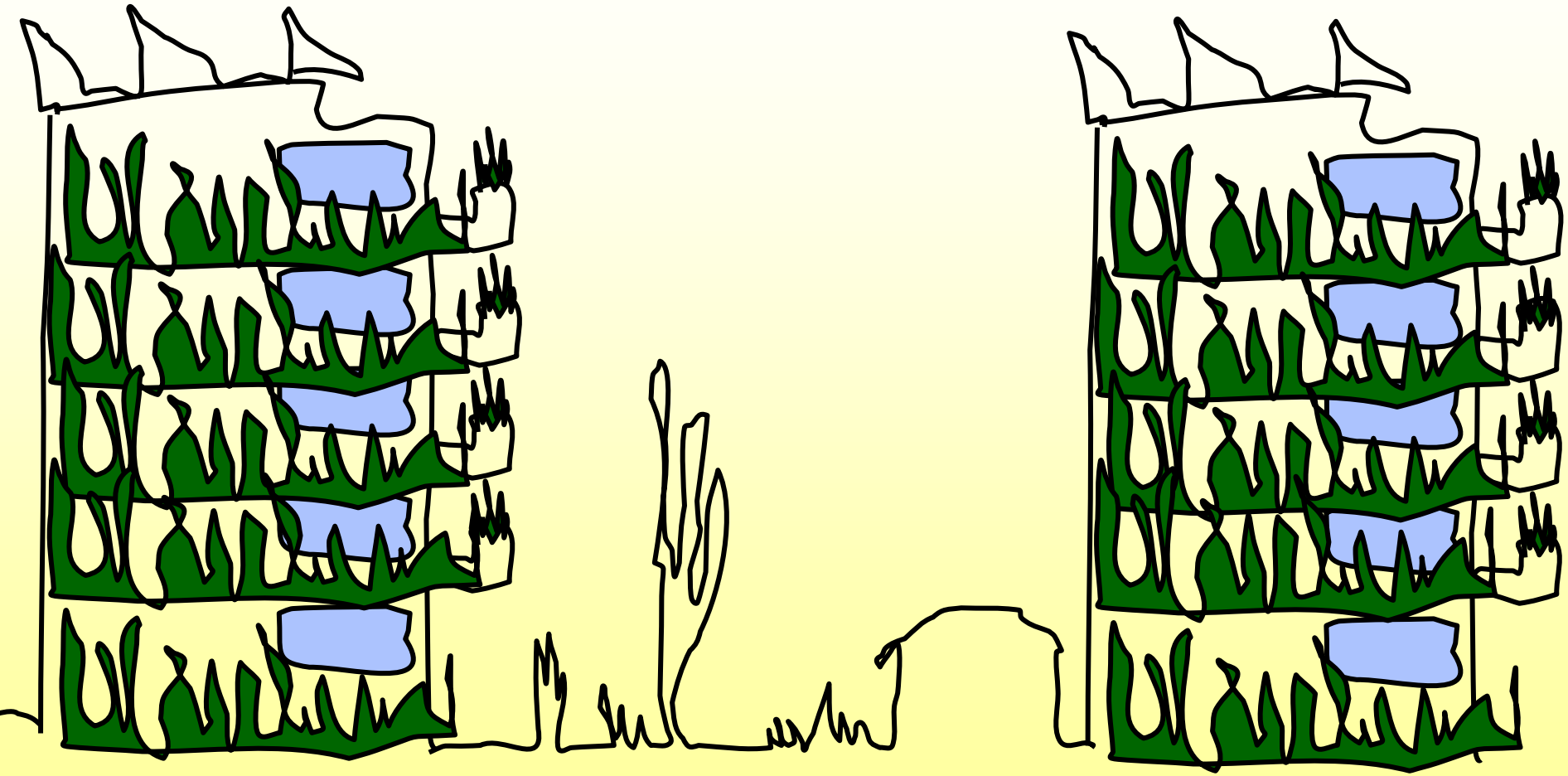
Part of Terra Preta (anthropogenic black soil) development, creating highly productive soil

Integrated urban bio-systems




Thank you for your attention!